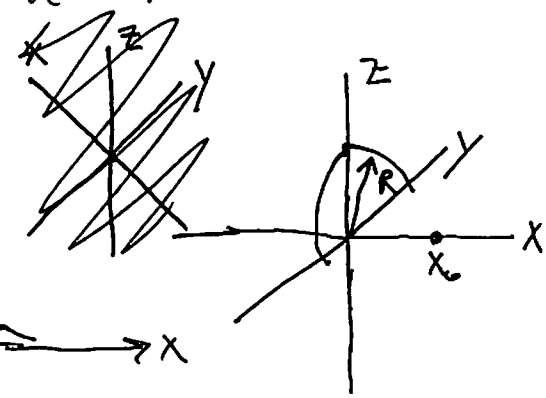
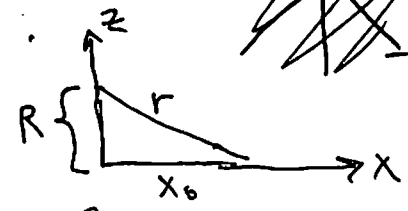
P2212 Student Problem 01/26/2010



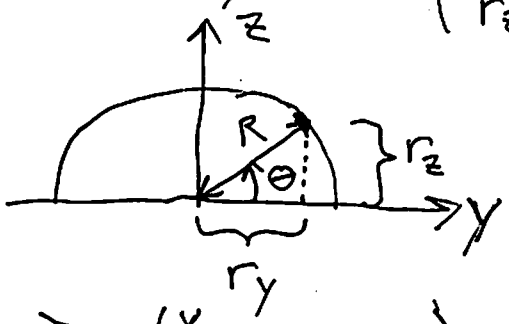
$\vec{E} = \frac{kq}{r^2}\hat{r}$, $\lambda = +\lambda_0$, $\lambda_0 > 0$



$dq = \lambda(x)\, d\theta R$

$\hat{r} = \frac{\vec{r}}{r}$, $r = R$ $r^2 = R^2 + x_0^2$

$\vec{r} = \begin{pmatrix} r_x \\ r_y \\ r_z \end{pmatrix}$, $r_x = x_0$



$r_y^2 + r_z^2 = R^2$

$r_z = R\cos\theta$ $r_z = -R\sin\theta$

$r_y = R\cos\theta$ $r_y = -R\cos\theta$

$\vec{r} = \begin{pmatrix} x_0 \\ R\cos\theta \\ -R\sin\theta \end{pmatrix}$ $\hat{r} = \frac{1}{\sqrt{R^2 + x_0^2}} \begin{pmatrix} x_0 \\ -R\cos\theta \\ -R\sin\theta \end{pmatrix}$,

$d\vec{E} = \frac{K(+\lambda_0)\, d\theta R}{R^2 + x_0^2} \frac{1}{\sqrt{R^2 + x_0^2}} \begin{pmatrix} x_0 \\ -R\cos\theta \\ -R\sin\theta \end{pmatrix}$

$x = R\cos\theta$

$\vec{E} = \int_{\text{along wire}} d\vec{E} = \int_0^{\pi} \frac{K(+\lambda_0)\, d\theta R}{(R^2 + x_0^2)^{3/2}} \begin{pmatrix} x_0 \\ -R\cos\theta \\ -R\sin\theta \end{pmatrix} = \frac{K\lambda_0 R x_0}{(R^2 + x_0^2)^{3/2}}$

$E_x = K\lambda_0$

$$\vec{E} = \frac{K\lambda_0 R}{(R^2 + x_0^2)^{3/2}} \begin{pmatrix} \pi x_0 \\ 0 \\ -2R \end{pmatrix}$$